

CLAIMS

What is claimed is:

1. A magnetic random access memory cell comprising:
 - a magnetic memory element having a top portion and a bottom portion;
 - a first write line below the magnetic memory element, the first write line being electrically connected with the bottom portion of the magnetic memory element;
 - 5 a second write line above the magnetic memory element, the second write line being electrically isolated from the magnetic memory element and oriented at an angle to the first write line.

2. The magnetic random access memory cell of claim 1 wherein the angle is ninety degrees.
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3. The magnetic random access memory cell of claim 1 further comprising:
 - a selection device residing below magnetic memory element and the electrically connected to the top portion of the magnetic memory element.
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4. The magnetic random access memory cell of claim 3 wherein the magnetic memory element is a magnetic tunneling junction device including a free layer having a changeable magnetic vector, a pinned layer having a fixed magnetic vector, and a thin

insulating tunneling layer between the free layer and the pinned layer.

5. The magnetic random access memory cell of claim 4 wherein the pinned layer with the fixed magnetic vector is deposited after the free layer and located on top of the thin insulating tunneling layer.

6. The magnetic random access memory cell of claim 4 wherein the pinned layer is deposited before the free layer and located beneath the thin insulating tunneling layer.

10 7. The magnetic random access memory cell of claim 6 wherein the pinned layer has substantially the same lateral shape as the first write line.

15 8. The magnetic random access memory cell of claim 1 wherein the second write line further includes a central portion and an edge region, the edge region including not facing the magnetic memory element, the edge region including a ferromagnetic cladding layer, thereby concentrating a magnetic field proximate to the magnetic memory element.

20 9. The magnetic random access memory cell of claim 8 wherein the ferromagnetic cladding layer is electrically isolated from the central portion of the second write line.

10. The magnetic random access memory cell of claim 1 wherein the first write line includes a soft magnetic material.

11. The magnetic random access memory cell of claim 10 wherein the first write line is magnetostatically coupled to the magnetic memory element.

12. The magnetic random access memory cell of claim 1 wherein the first write line is a multilayer structure including at least one nonmagnetic layer and at least one soft magnetic layer adjacent to the at least one nonmagnetic layer.

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13. The magnetic random access memory cell of claim 12 wherein the at least one soft magnetic layer includes a plurality of soft magnetic layers and wherein the at least one nonmagnetic layer includes a plurality of nonmagnetic layers, and wherein each of the plurality of soft magnetic layers is alternated with each of the plurality of nonmagnetic layers.

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14. The magnetic random access memory cell of claim 3 further comprising:
20 a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

wherein the magnetic memory element is formed within a region delineated by the

lateral geometry of the stud.

15. The magnetic random access memory cell of claim 3 further comprising:

a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

wherein the magnetic memory element is formed outside a region delineated by the lateral geometry of the stud.

10 16. The magnetic random access memory cell of claim 3 further comprising:

a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

wherein the magnetic memory element is formed partially within a region delineated by the lateral geometry of the stud.

15 17. The magnetic random access memory cell of claim 1 wherein the first write line includes at least one layer of ferromagnetic material; and

wherein the magnetic element is a magnetic tunneling junction device including a pinned layer, a portion of the at least one layer of the first write line functioning as the pinned layer.

18. A magnetic random access memory comprising:

a plurality of magnetic memory elements, each of the plurality of magnetic memory

elements having a top portion and a bottom portion;

5 a first plurality of write lines below the plurality of magnetic memory elements, a write line of the first plurality of write lines being electrically connected with the bottom portion of a corresponding magnetic memory element of the plurality of magnetic memory elements;

10 a second plurality of write lines above the plurality of magnetic memory elements, the second plurality of write lines being electrically isolated from the plurality of magnetic memory elements, the second plurality of write lines being oriented at an angle to the first plurality of write lines, the plurality of magnetic memory elements residing at intersections between the first plurality of write lines and the second plurality of magnetic write lines.

15 19. A method for providing magnetic random access memory cell comprising the

steps of:

(a) providing a first write line layer;

20 (b) providing a plurality of magnetic memory element layers above the first write line layer, a portion of the plurality of magnetic memory element layers being electrically connected to the first write line layer;

(c) defining a magnetic memory element and a first write line from the plurality of magnetic memory element layers and the first write line layer;

(d) providing a second write line above the magnetic memory element, the second write line being electrically isolated from the magnetic memory element and oriented at an angle to the first write line.

5 20. The method of claim 19 wherein the angle is ninety degrees.

21. The method of claim 19 further comprising the steps of:

(e) providing a selection device residing prior to providing the plurality of magnetic memory element layers; and

10 (f) providing a conductive layer for electrically connecting the selection device to the top portion of the magnetic memory element.

22. The method of claim 21 wherein the step of providing the plurality of magnetic memory element layers (b) further includes the steps of:

15 (b1) providing a free layer having a changeable magnetic vector;
(b2) providing a pinned layer having a fixed magnetic vector; and
(b3) providing a thin insulating tunneling layer between the free layer and the pinned layer.

20 23. The method of claim 22 wherein the pinned layer providing step (b2) further

includes the step of:

(b2i) depositing the pinned layer after the free layer and the thin insulating tunneling layer have been deposited.

24. The method of claim 22 wherein the pinned layer providing step (b2) further

includes the step of:

(b2i) depositing the pinned layer before the free layer and the thin insulating tunneling layer are deposited.

10 25. The method of claim 24 wherein the pinned layer has substantially the same

lateral shape as the first write line.

26. The method of claim 19 wherein the second write line providing step (d)

further the steps of:

15 (d1) providing a central portion of the second write line using a nonmagnetic material; and

(d2) providing an edge region of the second write line using a ferromagnetic cladding layer, the edge region including not facing the magnetic memory element, thereby concentrating a magnetic field proximate to the magnetic memory element.

27. The method of claim 26 wherein the ferromagnetic cladding layer is electrically isolated from the central portion of the second write line.

28. The method of claim 19 wherein the first write line layer providing step (a) further includes the step of:

- (a1) depositing a soft magnetic material.

29. The method of claim 28 wherein the first write line is magnetostatically coupled to the magnetic memory element.

30. The method of claim 19 wherein the first write line is a multilayer structure and wherein the first write line layer providing step (a) further includes the steps of:

- (a1) providing at least one nonmagnetic layer; and
- (a2) providing at least one soft magnetic layer adjacent to the at least one nonmagnetic layer.

31. The method of claim 30 wherein the at least one soft magnetic layer includes a plurality of soft magnetic layers and wherein the at least one nonmagnetic layer includes a plurality of nonmagnetic layers, and wherein each of the plurality of soft magnetic layers is alternated with each of the plurality of nonmagnetic layers.

32. The method of claim 21 further comprising the step of:

(g) providing a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

5 wherein the magnetic memory element is formed within a region delineated by the lateral geometry of the stud.

33. The method of claim 21 further comprising the step of:

(g) providing a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

10 wherein the magnetic memory element is formed outside a region delineated by the lateral geometry of the stud.

15 34. The method of claim 21 further comprising the step of:

(g) providing a conductive stud having a lateral geometry, the stud for electrically connecting the magnetic element and the selection device and residing between the magnetic memory element and the selection device; and

20 wherein the magnetic memory element is formed partially within a region delineated by the lateral geometry of the stud.

35. The method of claim 21 wherein the first write line layer providing step (a) further includes the step of:

(a1) providing at least one layer of ferromagnetic material; and

wherein the magnetic element is a magnetic tunneling junction device including a pinned layer, a portion of the at least one layer of the first write line functioning as the pinned layer.